

## APPENDIX H2

### Smoke Monitoring Report for 2004 and 2005

Rev. 11/05

This report summarizes the smoke monitoring activities for the calendar years 2004 and 2005. During the period of this report smoke monitoring was focused on burns associated with treating the BWCAW blowdown. Ten prescribed fires totaling 22,691 acres and one wildfire of 1335 acres were monitored. The following table summarizes the fires monitored.

Name	Acres	Dates of Major Fire Activity
Tuscarora	2836	9/9/04 & 9/12/04
Loon Lake	218	9/10/04
Mayhew Ridge	36	9/11/04
Larch Lake	3228	9/12/04
Snowbank Lake	1649	9/29/04
Alpine Wildfire	1335 (final)	8/7-17/05
Trout Lake	10,056	9/6-8/05
Knife Lake	1234	9/11/05
1-Island	313	9/30/05
Saucer	2569	10/1-2/05
Gunflint Palisades	552	10/2/05

A total of about 37 monitor-days were collected for these burns. A monitor-day is one monitor collecting data for one day. Of that about six and a half monitor days measured values over our benchmark of a rolling 24-hour average of 65 ug/m<sup>3</sup> (the EPA standard). It should be noted that the smoke monitors used by the forest are NOT EPA-approved to determine attainment of EPA standards. They do not have high enough precision or accuracy for that task. They give us a rough idea of the severity of the smoke at any given time.

In addition 18 monitor-days were collected for the Alpine wildfire. Of that total, roughly one monitor-day measured values over the EPA standard.

Overall what this data collection effort shows is that wind direction is the single most important variable to consider in mitigating smoke impacts. Even small changes in wind direction can either bring smoke towards a receptor or, alternatively away from it. The width of most smoke plumes observed have been about the same width as the width of the burn unit, perpendicular to the wind direction. Some of this is likely because most plumes have been observed less than 5 miles downwind of the burns. Nevertheless the plume widths observed are consistent with the output of the modeling tools used in burn plan preparation which gives me confidence in them. Although smoke plumes can rise high into the atmosphere and potentially travel over some receptors for much of the day, there will always be some mixing down of the plume to the surface and the plume will always fall in the evening making wind direction the dominant consideration.

In the opinion of the report writer, the second most important variable is hours of sun, especially in the morning. Sunny conditions promote early breakup of the morning surface inversion (if present) and promote mixing and thereby lifting of the mixing height. Sunny conditions also promote more active fire behavior which leads to higher plume rise. The third most important variable is the lighting pattern and speed – they should hopefully be used to promote a hot, plume-dominated fire.

We also learned this year on the Trout fire that smoke impacts, although they may be narrow in width, can travel great distances, especially when the burn is large. Smoke from the Trout burn carried 70+ miles downwind into Canada. This highlights a concern, specifically that burn writers should not assume that sending a plume into Canada means there will be no

concerns. Especially for the larger burns left on the eastside of the forest, transporting smoke toward populated centers like Thunder Bay is possible and could cause numerous complaints. By the same token, small native population centers in the more remote regions of Ontario could also be a concern. Identifying all such reservations on a combined US/Canada map should be pursued in cooperation with OMNR.

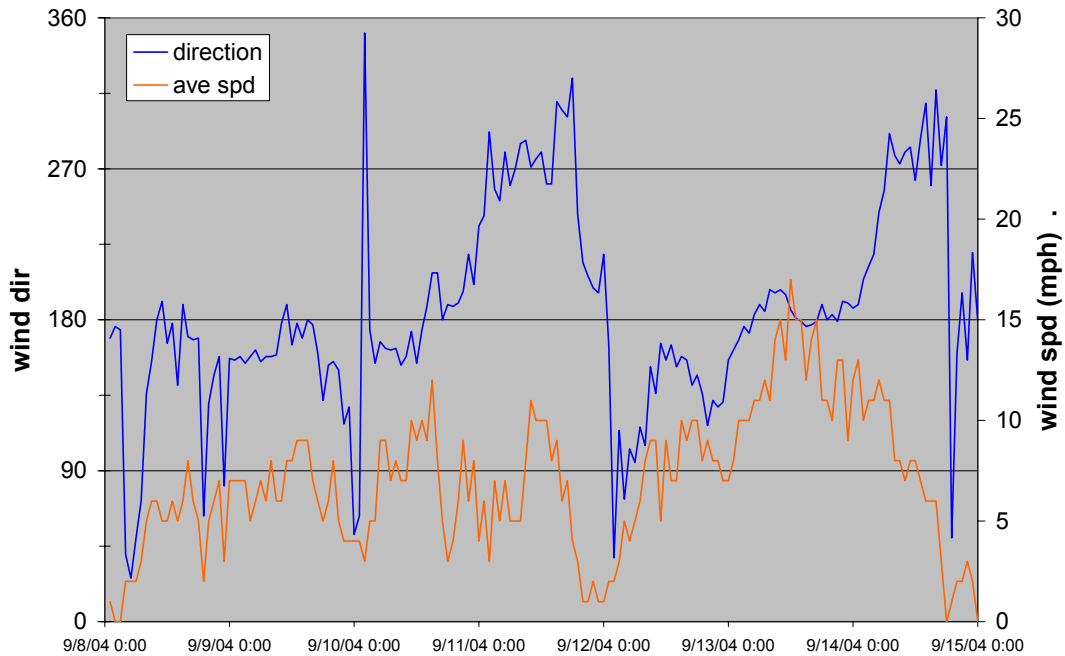
A more specific discussion of each burn follows. The burns are grouped by burn window and weather and satellite photo information is included with the smoke monitor data.

### Tuscarora/Loon/Mayhew Ridge/Larch Lake Burns

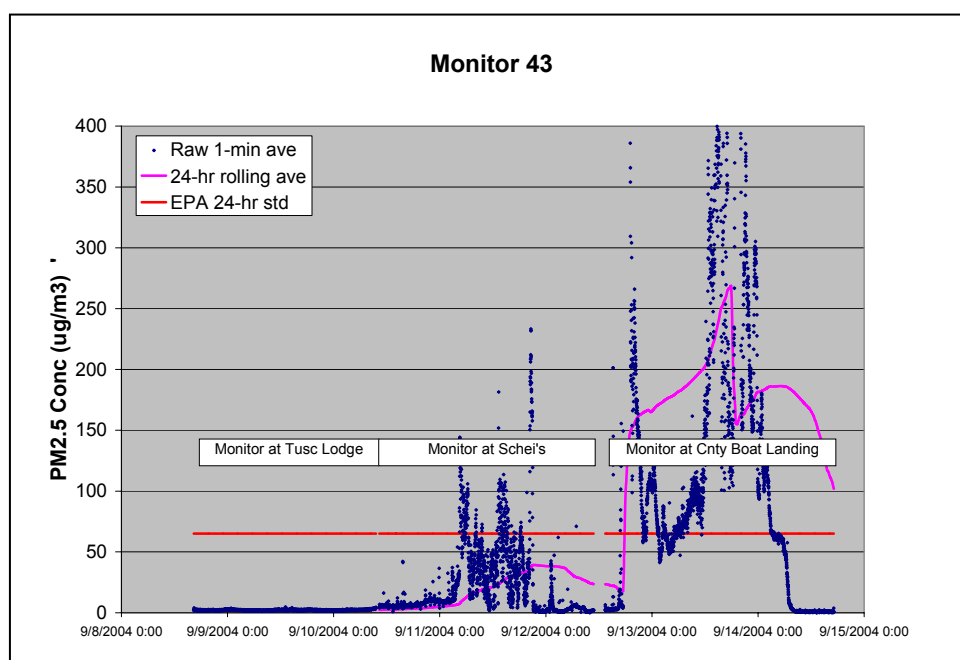
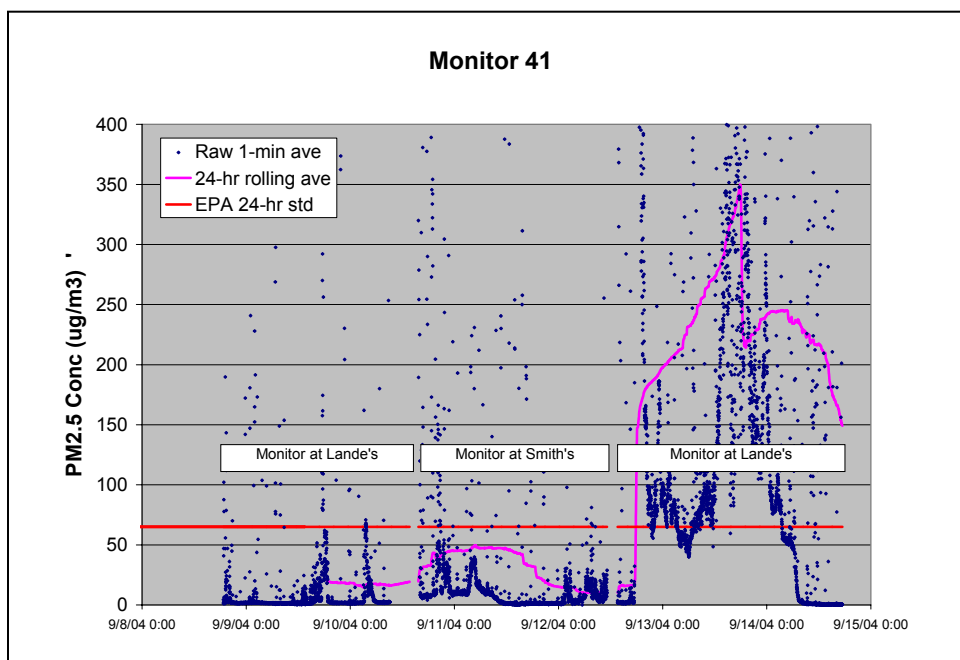
Name	Acres	Dates of Major Fire Activity
Tuscarora	2836	9/9/04 & 9/12/04
Loon	218	9/10/04
Mayhew Ridge	36	9/11/04
Larch Lake	3228	9/12/04

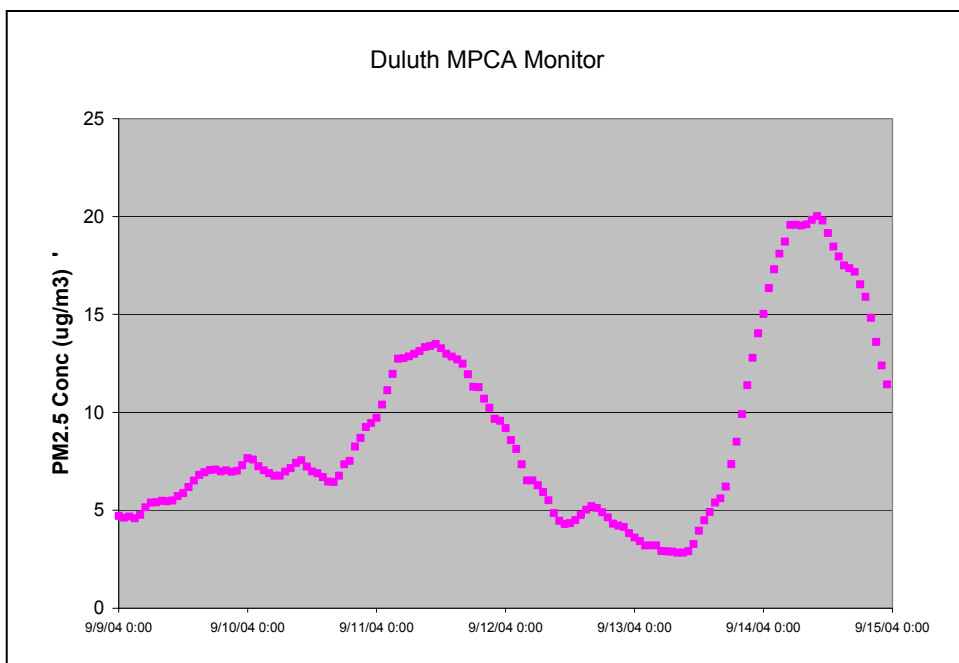
The graph below shows the wind direction and speed during the burns.

#### **Seagull Winds**



The following graphs show the fine particulate concentrations measured by the smoke monitors deployed during the burns and the background air quality as measured by the MPCA's EPA-approved monitor in Duluth.





### Discussion of Data Collected

On September 9 when Tuscarora was lit and during that day the winds were from the S or SE which carried the smoke generally to the west of the tip of Gunflint trail. Overall there were no readings above the EPA standard.

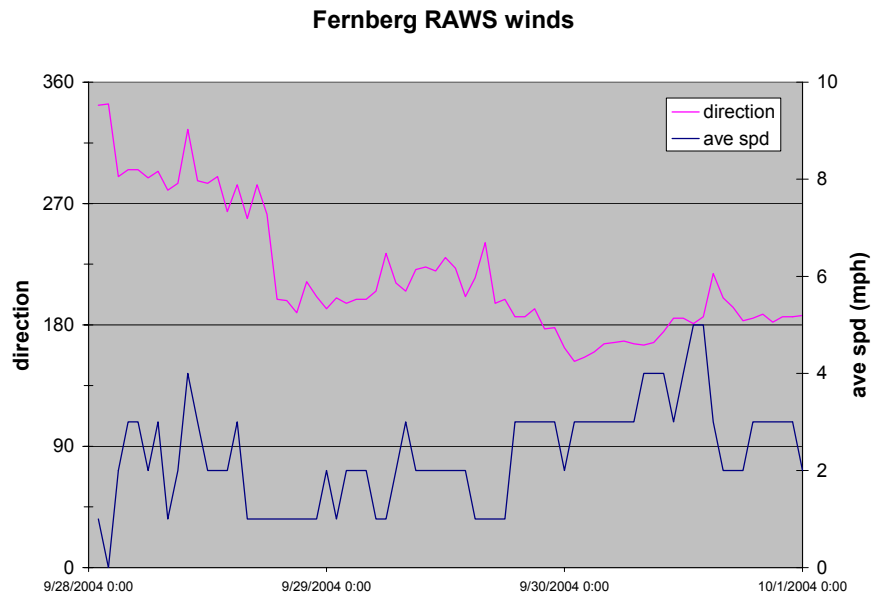
From September 10 through 12 the monitors documented the impacts of the Loon and Mayhew Ridge burns. During the 10<sup>th</sup> through the 11<sup>th</sup> the winds were from between the S and the W which generally took the smoke away from the populated areas nearby. Despite being located within a mile of the burns on the north and south side of Loon Lake none of the monitors exceeded the EPA standard.

On September 12<sup>th</sup> Larch Lake was lit and winds were from the SE during the day. In the evening the winds picked up and turned straight out of the S. On this day Tuscarora flared up enough to require aerial resources. The monitors were redeployed prior to lighting Larch to locations generally northwest of Larch and North of Tuscarora. Both monitors showed remarkably similar and high impacts on the evening of the 12<sup>th</sup> through the early morning of the 14<sup>th</sup>. The winds stayed straight out of the S through the 13<sup>th</sup> and then swung to the northwest early on the 14<sup>th</sup>. Based on the wind direction it would seem that Tuscarora was affecting the monitors more than Larch, but smoke from Larch may have dispersed laterally enough to impact either monitor and add to the impact of Tuscarora. Smoke impacts were over the EPA standard for about 2 days for residents living on the Gunflint Trail beyond the seagull guard station. If Tuscarora had more completely burned out during the previous three days the smoke impacts would not have been as severe.

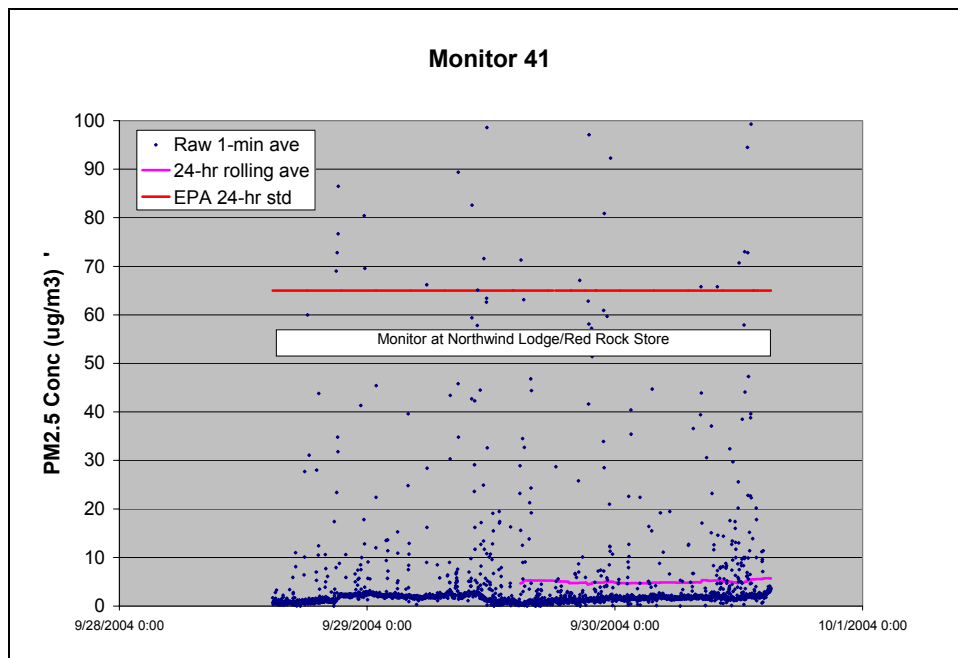
## Snowbank Lake Burn

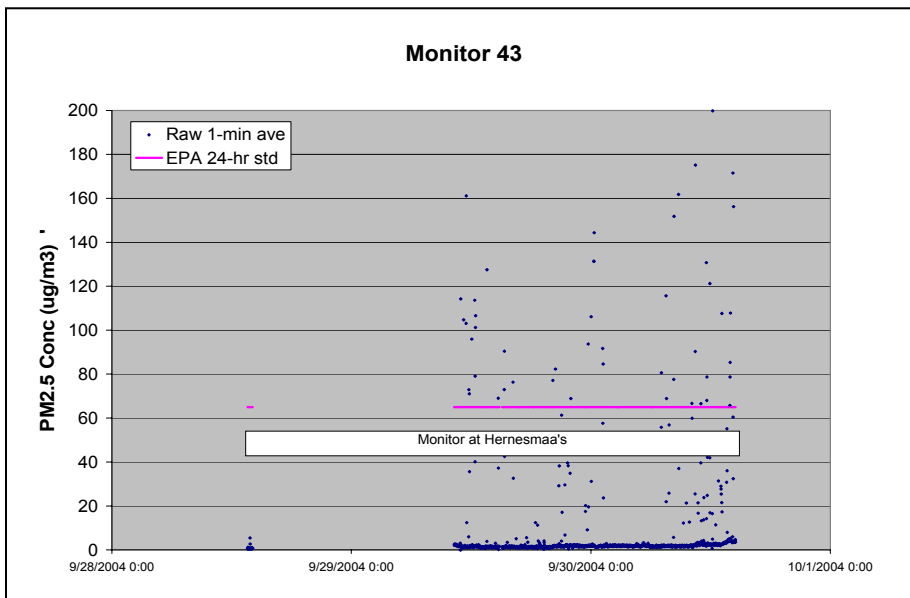
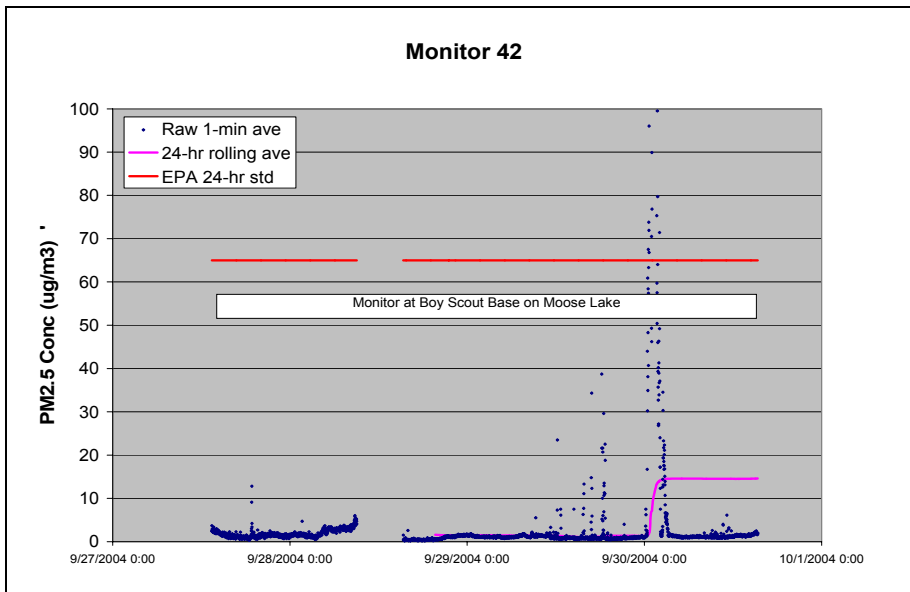
Name	Acres	Dates of Major Fire Activity
Snowbank	1649	9/29/04

The graph below shows the wind direction and speed during the burns.



The following graphs show the fine particulate concentrations measured by the smoke monitors deployed during the burns.





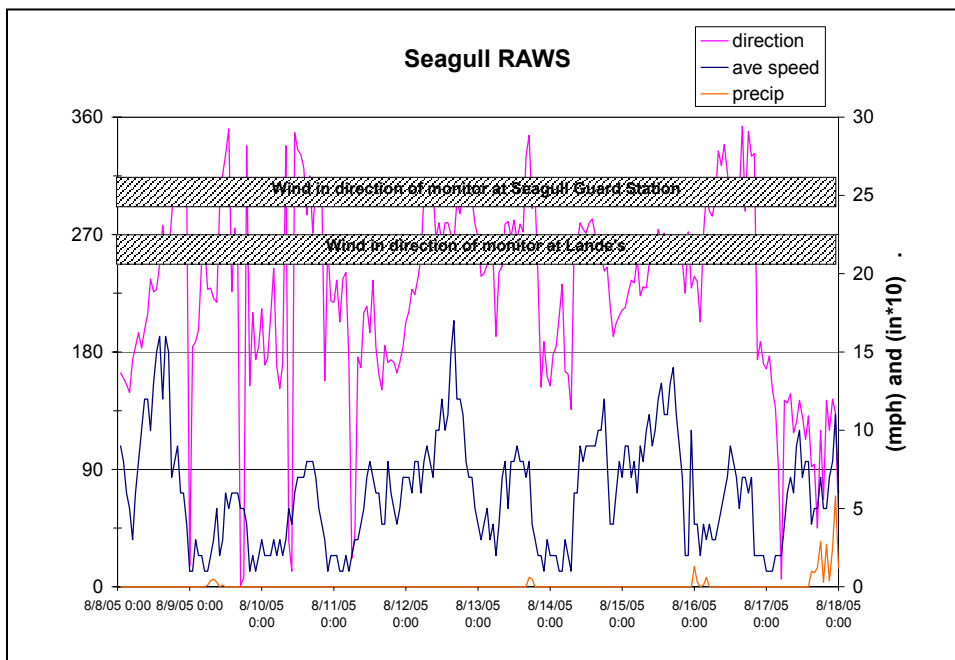
### Discussion of Data Collected

Winds during the burn were out of the S for the entire portion of the major burning period which carried the smoke away from populated areas on the Fernberg Road. The satellite view available that was taken at noon on the 29<sup>th</sup> also shows the smoke traveling northeast away from the burn. Upper-level winds are usually turned clockwise from the surface winds. The only monitor that showed some impacts was the one at the Boy Scout base which was almost on the south boundary of the burn unit. This was during the early morning after lighting on the 29<sup>th</sup> and was likely due to the plume falling and following the slope of the terrain and flowing out in all directions under the lower early morning winds. Even these impacts were only about 25% of the EPA standard. Overall there were no readings above the EPA standard.

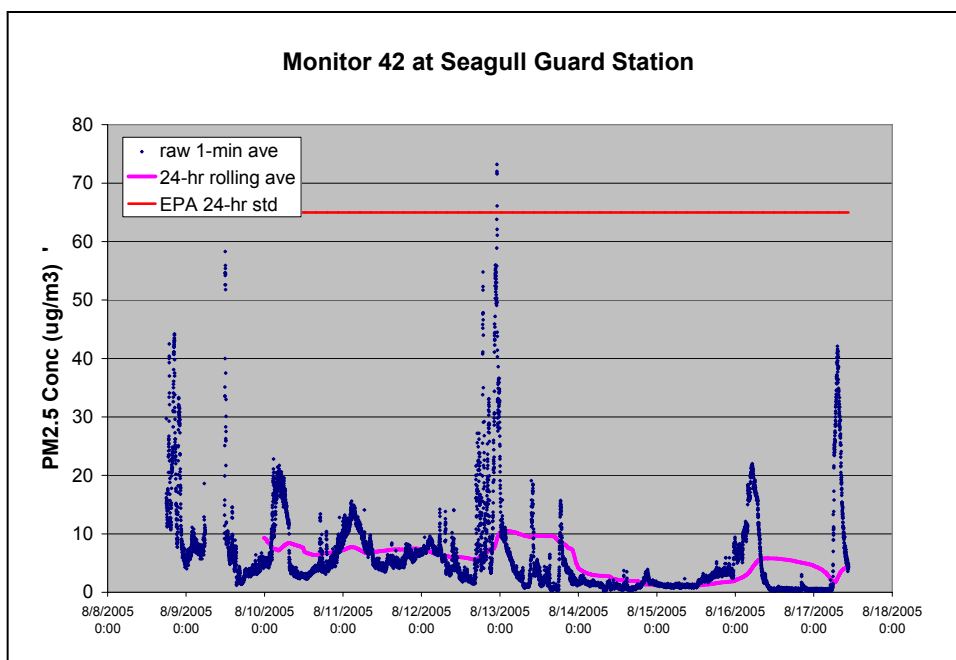
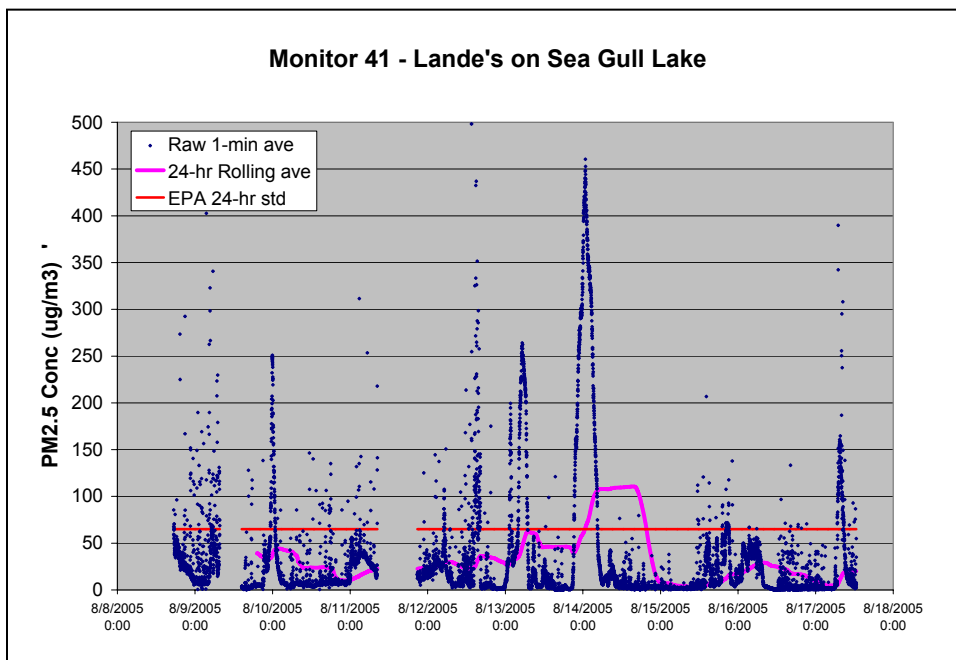
### Alpine Lake Wildfire

Name	Acres	Dates of Major Fire Activity
Alpine Wildfire	1335	8/7-17/05

The graph below shows the wind direction, speed, and precipitation during the wildfire.



The following graphs show the fine particulate concentrations measured by the smoke monitors deployed during the wildfire.





**Satellite View taken at 13:00 on 8/7/05 showing  
Alpine and other Ontario Fires**

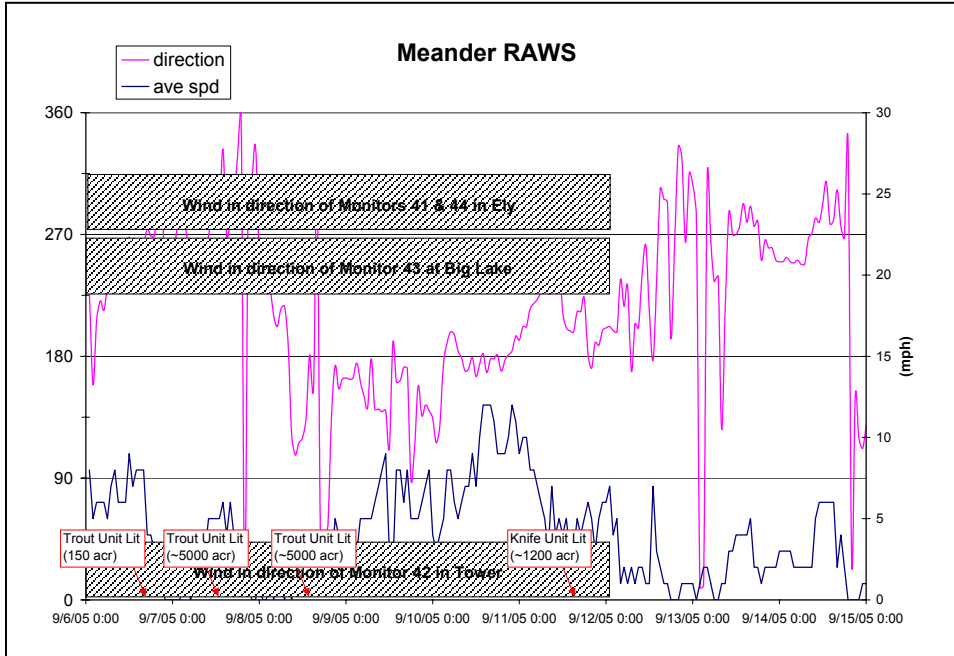
### **Discussion of Data Collected**

Data from the monitor at the Seagull Guard Station show no impacts over the EPA standard. This would imply that no one further down the Gunflint Trail experienced impacts over the standard since the remainder of the Trail is in the same general direction from the fire as the guard station. On the afternoon of the 13<sup>th</sup> and 14<sup>th</sup> the monitor at the Lande's on the north side of Sea Gull Lake saw the highest levels of smoke during the monitored period with the readings on the 14<sup>th</sup> above the EPA health standard for about 1 day. These times correlated well with the time period the wind direction was pointed at the monitor. The monitor was about 3 miles downwind of the fire. It is much harder to estimate how many acres were actually burning, and hence how much smoke was being put into the atmosphere, on any given day during a wildfire versus a prescribed fire. No other non-cloud obstructed satellite views were available.

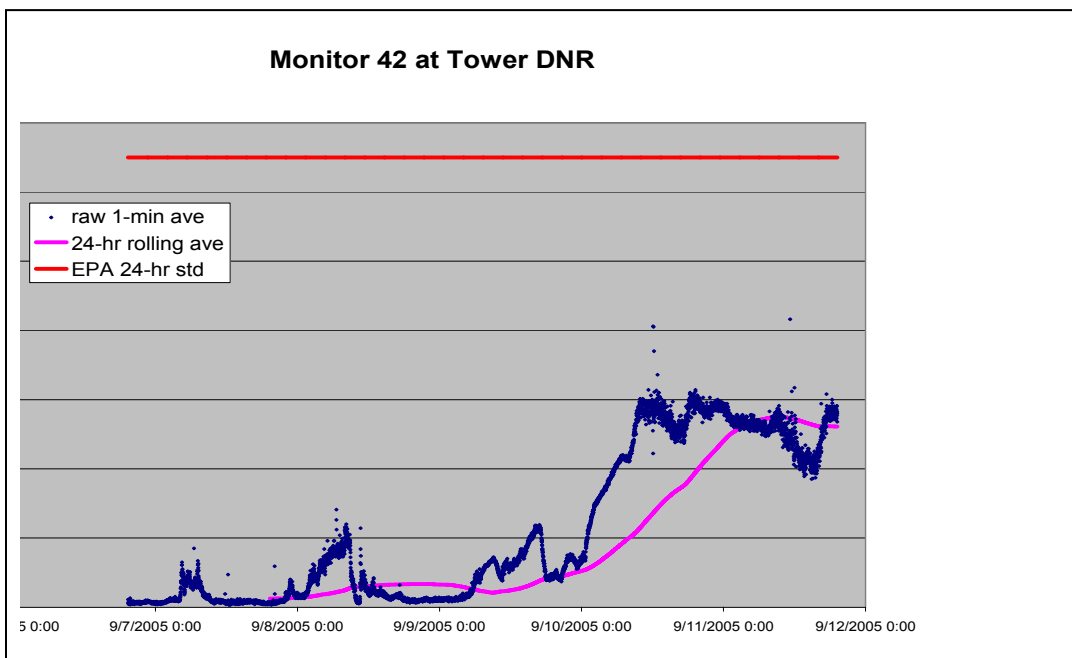
## Trout and Knife Lake Burns

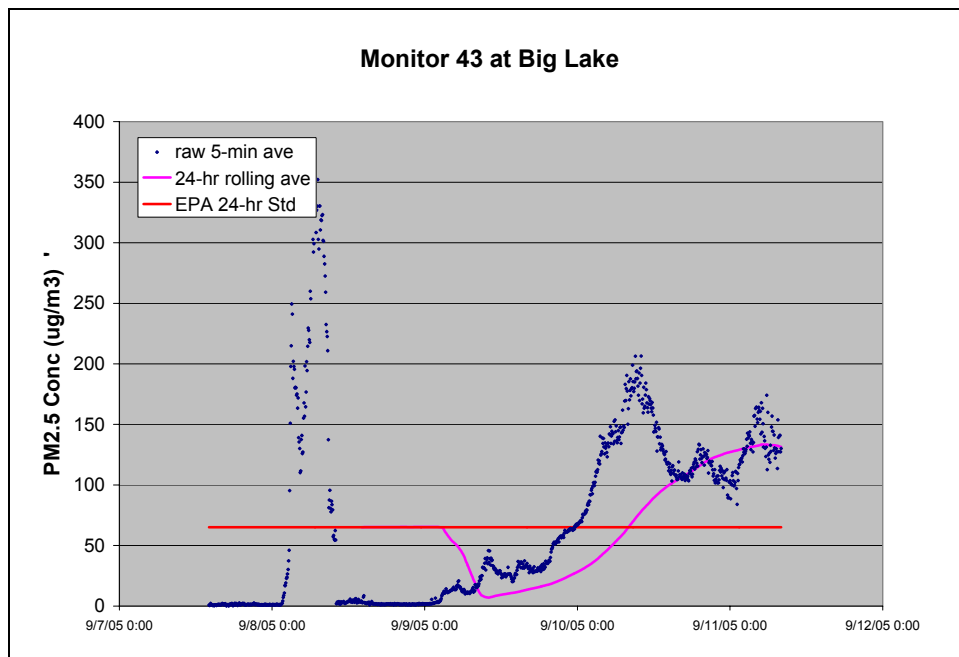
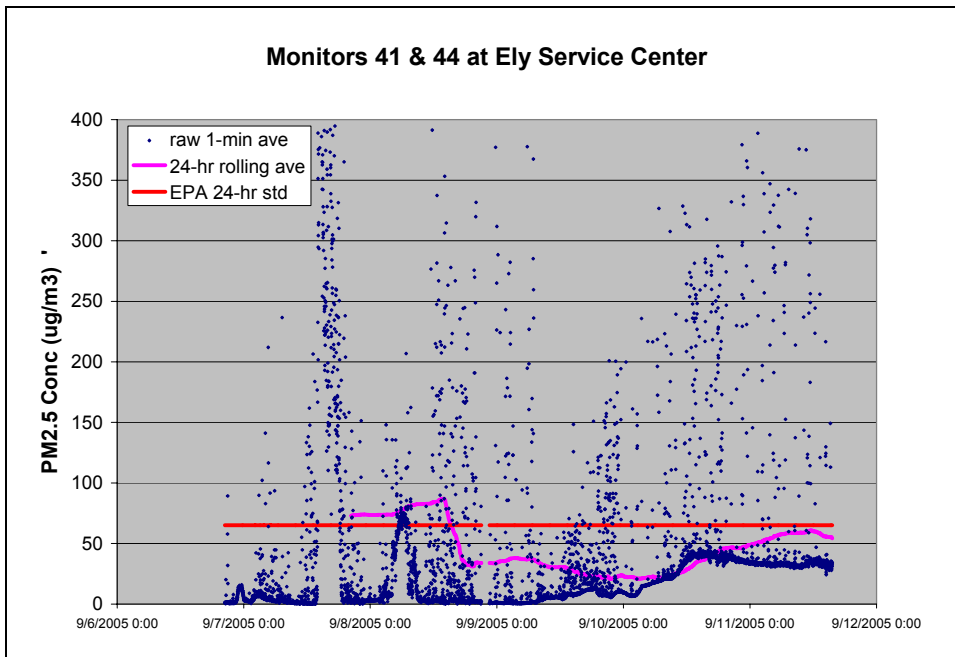
Name	Acres	Dates of Major Fire Activity
Trout Lake	10,056	9/6-8/05
Knife Lake	1234	9/11/05

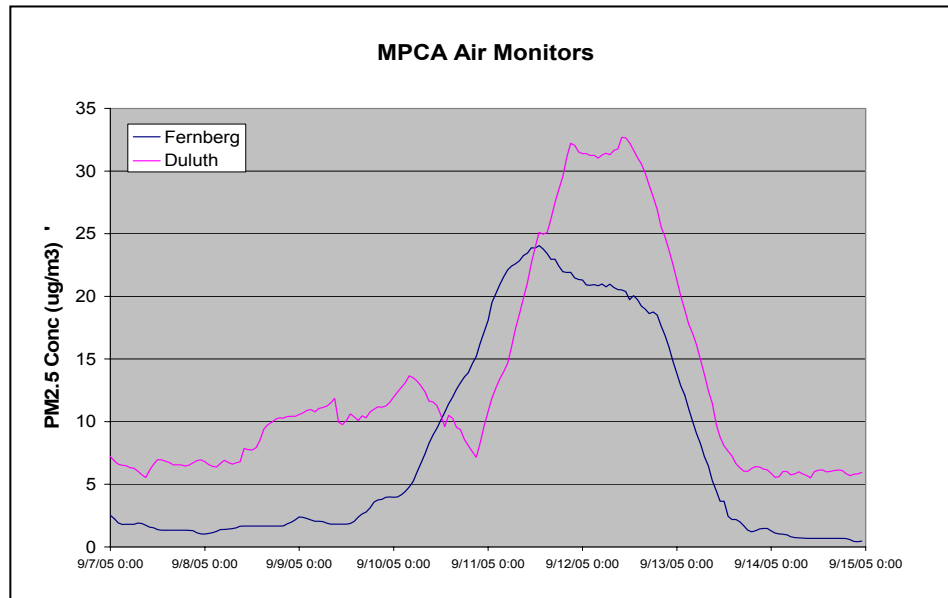
The graph below shows the wind direction and speed during the burns.

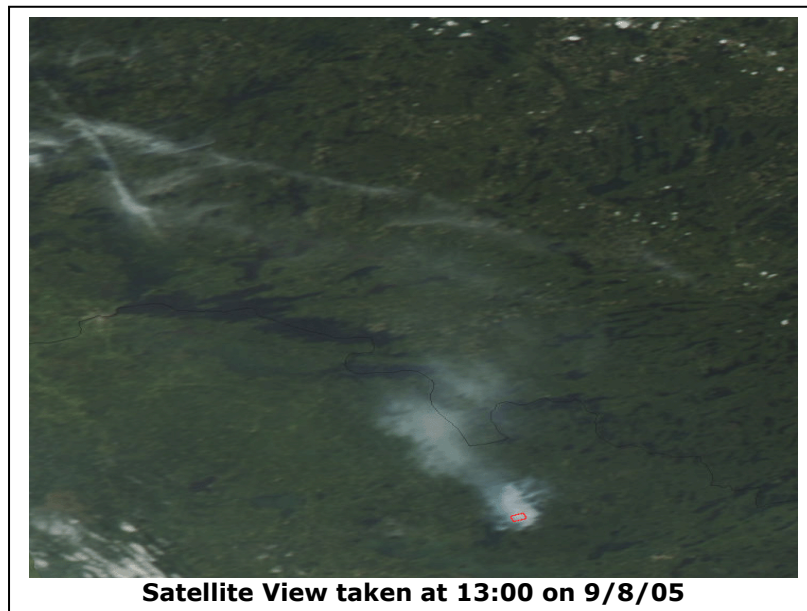


The following graphs show the fine particulate concentrations measured by the smoke monitors deployed during the burns and the background air quality as measured by the MPCA's EPA-approved monitors at Fernberg and Duluth.









**Satellite View taken at 13:00 on 9/8/05**

### **Discussion of Data Collected**

Out of all the units planned for burning in response to the BWCAW blowdown, the Trout unit is probably the one with the largest potential for adverse smoke impacts. The unit is large (over 10,000 acres) and near some of the most populated areas near the forest (Ely, Tower, etc.). The burn was started on September 6<sup>th</sup> when only about 150 acres was burned. The smoke monitors at Tower and Ely were deployed that night. No smoke impacts were noted that night. The wind was generally out of the west.

On the 7<sup>th</sup>, half of the remaining unit was burned. The winds were generally from the west all day driving the plume east slightly north of Ely – which the satellite photo at 14:00 on the 7<sup>th</sup> shows. As evening drew near the plume from the fire swung a little more south from just a little north of Ely to almost directly over it. At around 17:00 I alerted public information staff that should the plume stay where it was in the air it would fall on the town that evening and likely cause concentrations that would be a health concern. . Ash began falling out in town and Fall Lake Campground at around 19:00. Fortunately just as it began to get dark the upper level winds swung the smoke column back north of Ely and the major populated areas to the east and west of town. The plume likely fell very near the monitor at Big Lake and caused the large peak early on the morning of the 8<sup>th</sup>. The earlier impacts from the plume when it was over Ely are shown by the peak in the afternoon from the monitor at the service center. The peak on this monitor in the early morning of the 8<sup>th</sup> does not seem to be attributable to the burn since the wind is in the wrong direction. It may have been due to truck activity at the service center since it peaks at 7:00 which is when the morning briefing takes place.

On the 8<sup>th</sup> the remaining ~ 5000 acres of the unit was burned. Winds were generally from the S/SE during the day and light although they were variable at times. Due to the high pressure system being directly over the site that day more locally influenced and spatially variable wind patterns developed due to local land/lake and terrain features. The wind direction seemed to vary quite a bit depending on location. Winds in the afternoon on Fall Lake were easterly. We were told by DNR staff that smoke was experienced on Lake Vermillion on Ely Island at 17:00 which is located about 8 miles *south* of the burn. The upper level winds seemed to remain fairly southerly all day as the plume moved north. This is confirmed by the satellite photos for the 8<sup>th</sup>. The smoke is visible in these photos for about 35 miles downwind. On the afternoon of the 8<sup>th</sup> the public information folks received a call from the Ojibwe Reservation on the north side of Lac La Croix in Canada that they were experiencing unhealthy levels of smoke. The reservation is about 20 miles straight north of the burn. Based on the wind direction and satellite photos it seems plausible that smoke traveled in that direction on the 8<sup>th</sup>. Contact with Ontario MNR the next day also confirmed that smoke, most likely from this fire, reached Fort Francis and

possibly Dryden in Canada on the evening of the 8<sup>th</sup> although no widespread complaints were registered with OMNR.

The next two days (9<sup>th</sup> and 10<sup>th</sup>) saw fire forces work on holding the Trout burn. Winds were from the S/SE during this time and picked up in speed. The plume was pushed north. We again received concerns from the same Ojibwe reservation on the 10<sup>th</sup>. Perhaps the stronger winds were effective in transporting the smoke remaining from the burn to the reservation. There was consideration of flying to the reservation on the morning of the 9<sup>th</sup> and deploying a monitor but after talking with the contact at the reservation, on the morning of the 9<sup>th</sup>, who said the air was clear, it was decided to not go. In hindsight it may have been a better choice if we had deployed the monitor since the monitor would have provided the fire managers quantitative data on the smoke impacts over the next few days and also possibly been interpreted by the reservation as a display of goodwill.

Knife was lit on the 11<sup>th</sup> with an S/SW wind. The smoke was carried away toward the northeast and away from residents. The satellite photo on the 11<sup>th</sup> is before the major fire activity on the Knife fire but it also shows that the smoke from the Trout fire was much diminished compared to the previous few days. It is undetectable in this photo.

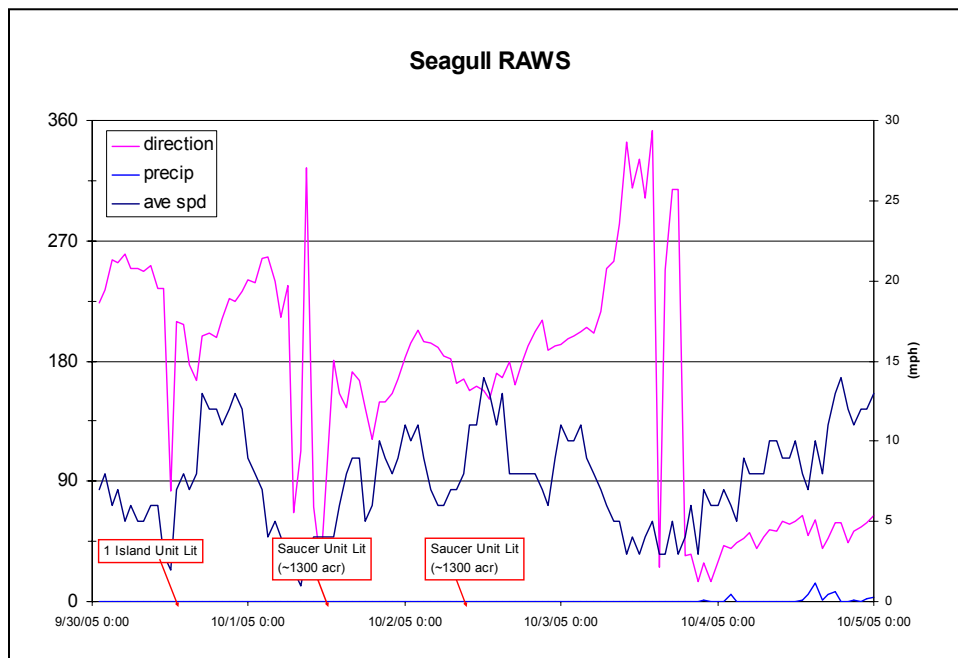
On the morning of the 10<sup>th</sup> background air quality deteriorated. Background air quality of fine particulate matter went from levels of around 5 ug/m<sup>3</sup> to up to the mid 20 ug/m<sup>3</sup> range. This was detected by both the MPCA monitors and our smoke monitors.

To summarize - there were no impacts measured in Tower by that monitor during the burn. The monitor at Ely measured values over the EPA standard for about one 24-hour period immediately following the second day of lighting of the Trout burn. After values dropped in Ely they rose at Big Lake and were over the standard for about half a day. Later at that same monitor values rose above the standard again. This rise does not correlate well with the wind direction measured on the 10<sup>th</sup>, but does for the peak on the 11<sup>th</sup>. It is impossible to know for sure the exact source of all the smoke monitored at this monitor for those days.

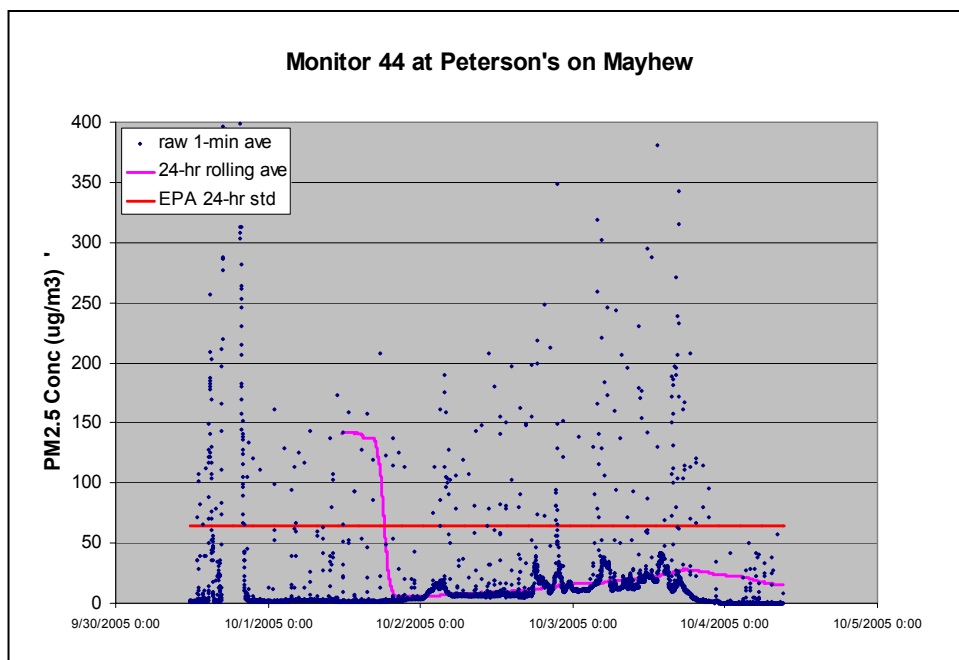
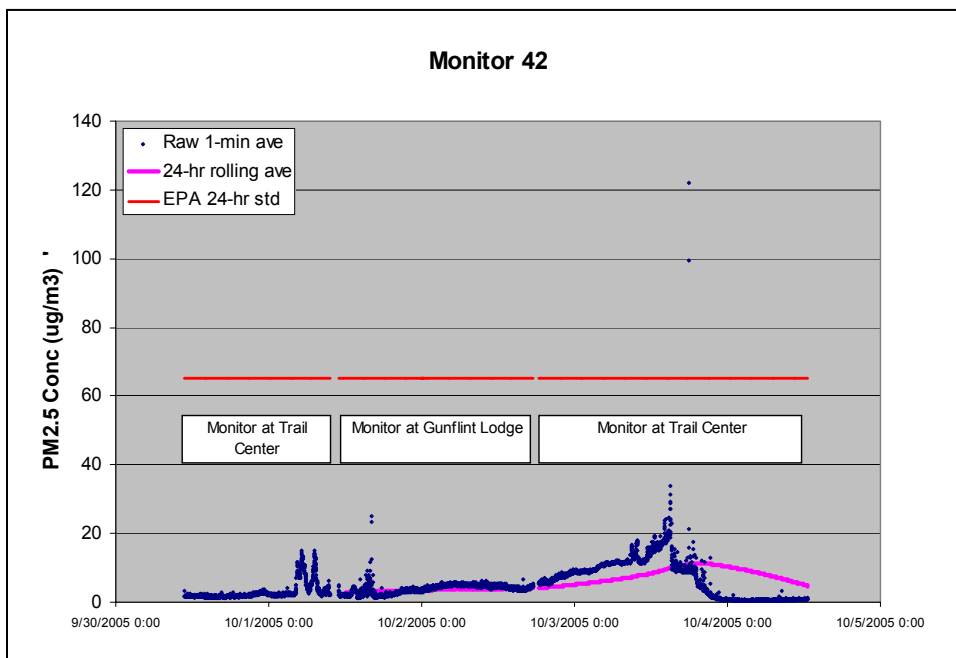
## 1 Island/Saucer/Gunflint Palisades Burns

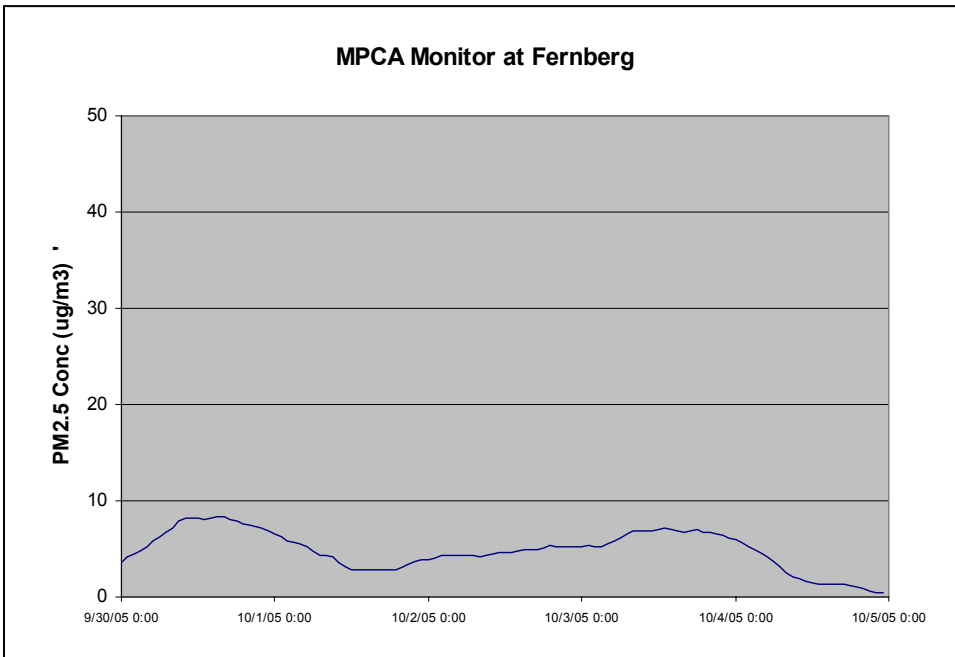
Name	Acres	Dates of Major Fire Activity
1-Island	313	9/30/05
Saucer	2569	10/1-2/05
Gunflint Palisades	552	10/2/05

The graph below shows the wind direction and speed during the burns.



The following graphs show the fine particulate concentrations measured by the smoke monitors deployed during the wildfire.





### Discussion of Data Collected

The winds during the majority of the burn window on the 30<sup>th</sup> were from between E and SW but predominantly S. Winds took the smoke from the 1-Island burn directly to the monitor at the Peterson's on Mayhew Lake which was less than two miles away. During the first evening after this burn this monitor was impacted over the standard for less than a half day. The following days smoke continued to be transported in the general direction of the monitor but the strength of the smoke from the burn was much less than the first day and the levels never again rose above the EPA standard.

Monitor 42 was initially deployed at Trail Center for the 1-Island burn and was unimpacted on the first burning day. It was then relocated to the Gunflint Lodge on the 1<sup>st</sup> for the Saucer burn and was also not impacted during the first burning period. In anticipation of a wind switch to the NW this monitor was redeployed back to Trail Center late on the 2<sup>nd</sup> to capture any smoke transport down the trail. Trail Center was about 6 miles downwind from Saucer. The wind did switch to the NW for about half the day on the 3<sup>rd</sup> but very little impact was detected.